

## 4. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

### 4.1 PRODUCTION

According to the United States International Trade Commission publication on U.S. production and sales of synthetic organic chemicals (USITC 1991), 802.6 million pounds of 1,1,1-trichloroethane were produced in 1990. Three chemical companies are listed as domestic manufacturers in 1994: Dow Chemical in Freeport, Texas; Vulcan Materials Co. Chemicals Division in Geismar, Louisiana; and PPG Industries in Lakes Charles, Louisiana (SRI 1994). The estimated total production capacity at each of the facilities in 1994 (in millions of pounds) is 500 for Dow's plant in Freeport, Texas; 350 for PPG's plant in Lake Charles, Louisiana; and 200 for Vulcan's plant in Geismar, Louisiana (estimated total capacity of 1,050 million pounds as of January 1, 1994) (SRI 1994). The estimated total capacity at these facilities was 1,062 million pounds as of January 1, 1991 (SRI 1991). U.S. production in 1990 was  $\approx 76\%$  of capacity. The total production volume of 1,1,1-trichloroethane in previous years by the same manufacturers was 723.7 and 783.1 million pounds in 1988 and 1989, respectively (USITC 1989, 1990). The demand for 1,1,1-trichloroethane exhibited a 0.8% growth per year from 1982 to 1991. Future growth has been projected to decline 11.6% per year through 1996 (Chemical Marketing Reporter 1992). According to the 1990 amendments to the Clean Air Act and the Montreal Protocol, U.S. production of 1,1,1-trichloroethane will be cut incrementally until the proposed phase-out occurs by January 1996 (EPA 1993). Despite the mandated cuts in production, supplies of 1,1,1-trichloroethane should remain available over the next 5 years due to decreased demand as a result of availability of substitutes (Chemical Marketing Reporter 1992).

Besides the above producers of 1,1,1-trichloroethane, Table 4-1 reports the number of facilities in each state that manufacture and process 1,1,1-trichloroethane, the intended use of the product, and the range of maximum amounts of 1,1,1-trichloroethane stored on site. The data reported in Table 4-1 are derived from the Toxics Release Inventory (TRI) (TRI92 1994). Only certain types of facilities were required to report to the TRI databank of EPA. Hence, this is not an exhaustive list.

The most common method for industrial preparation of 1,1,1-trichloroethane is the reaction of hydrochloric acid with vinyl chloride (obtained from 1,2-dichloroethane) to obtain 1,1-dichloroethane, followed by either thermal or photochemical chlorination. Other methods include the catalyzed addition of hydrogen chloride to 1,1-dichloroethylene, and the direct chlorination of ethane itself,

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Table 4.1 Facilities That Manufacture or Process 1,1,1-Trichloroethane

State <sup>a</sup>	Number of facilities	Range of maximum amounts on site in thousands of pounds <sup>b</sup>	Activities and uses <sup>c</sup>
AL	41	0-100	1, 2, 3, 8, 10, 11, 12, 13
AR	43	0-100	8, 11, 12, 13
AZ	42	0-1000	2, 3, 7, 8, 9, 11, 12, 13
CA	470	0-50000	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13
CO	22	0-100	2, 8, 9, 11, 12, 13
CT	109	0-1000	2, 3, 6, 8, 9, 10, 11, 12, 13
DE	1	1-10	2, 3, 8, 10, 12
FL	65	0-100	1, 2, 3, 8, 9, 10, 11, 12, 13
GA	84	0-1000	2, 3, 4, 8, 9, 10, 11, 12, 13
IA	41	0-1000	8, 10, 11, 12, 13
ID	2	1-10	12, 13
IL	167	0-50000	1, 2, 4, 7, 8, 9, 10, 11, 12, 13
IN	134	0-1000	1, 2, 3, 8, 9, 10, 11, 12, 13
KS	27	0-1000	2, 3, 8, 9, 10, 11, 12, 13
KY	43	0-10000	2, 7, 8, 10, 12, 13
LA	22	0-50000	1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12,
MA	92	0-1000	2, 3, 8, 9, 10, 11, 12, 13
MD	28	1-1000	8, 10, 11, 12, 13
ME	17	0-100	11, 12, 13
MI	106	0-10000	1, 2, 3, 4, 5, 8, 9, 10, 11, 12, 13
MN	70	0-1000	2, 3, 7, 8, 9, 10, 11, 12, 13
MO	72	0-500000	2, 3, 8, 9, 10, 11, 12, 13
MS	37	0-1000	2, 3, 4, 8, 9, 10, 11, 12, 13
NC	133	0-1000	2, 3, 8, 9, 10, 11, 12, 13
ND	4	1-100	11, 13
NE	24	1-100	8, 11, 12, 13
NH	27	0-100	8, 10, 12, 13
NJ	86	0-10000	2, 3, 7, 8, 10, 12, 13
NM	6	0-100	8, 9, 12, 13
NV	2	0-100	13
NY	127	0-1000	1, 2, 3, 6, 7, 8, 9, 10, 11, 12, 13
OH	226	0-50000	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13
OK	29	0-100	8, 10, 11, 12, 13
OR	17	0-100	8, 11, 12, 13
PA	145	0-1000	2, 3, 8, 9, 10, 11, 12, 13
PR	16	0-100	8, 9, 13
RI	38	0-100	2, 3, 8, 11, 12, 13
SC	52	0-10000	2, 3, 8, 9, 10, 11, 12, 13
SD	8	0-100	11, 12, 13
TN	77	0-1000	2, 3, 5, 8, 10, 11, 12, 13

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**Table 4.1 Facilities That Manufacture or Process 1,1,1-Trichloroethane (continued)**

State <sup>a</sup>	Number of facilities	Range of maximum amounts on site in thousands of pounds <sup>b</sup>	Activities and uses <sup>c</sup>
TX	150	0-10000	1, 2, 3, 4, 7, 8, 9, 10, 11, 12, 13
UT	20	0-1000	8, 9, 12, 13
VA	47	0-100	7, 8, 11, 12, 13
VI	1	10-100	7
VT	15	1-100	11, 12, 13
WA	30	0-1000	1, 2, 3, 5, 8, 11, 12, 13
WI	111	0-1000	7, 8, 10, 11, 12, 13
WV	5	1-100	10, 12, 13

Source: TRI92 1994

<sup>a</sup>Post office state abbreviations used<sup>b</sup>Data in TRI are maximum amounts on site at each facility.<sup>c</sup>Activities/Uses

- |                               |                                  |
|-------------------------------|----------------------------------|
| 1. Produce                    | 8. As a formulation component    |
| 2. Import                     | 9. As a product component        |
| 3. For on-site use/processing | 10. For repackaging              |
| 4. For sale/distribution      | 11. As a chemical processing aid |
| 5. As a byproduct             | 12. As a manufacturing aid       |
| 6. As an impurity             | 13. Ancillary or other uses      |
| 7. As a reactant              |                                  |

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followed by separation from the other products produced (Archer 1979). Commercial grades of 1, 1, 1 -trichloroethane usually contain some inhibitor, such as nitromethane, methyl ethyl ketone, toluene, 1,6-dioxane, butylene oxide, 1,3-dioxolane, or secondary butyl alcohols (Archer 1979; OHM/TADS 1992).

**4.2 IMPORT/EXPORT**

According to the Commerce Department's National Trade Data Bank (NTDB 1994), the following amounts of 1,1,1-trichloroethane (in pounds with kg in parentheses) were exported from the United States during the period 1989-1993: 124.3 million (56.4 million) in 1989; 114.6 million (52.0 million) in 1990; 162.4 million (73.7 million) in 1991; 139.7 million (63.4 million) in 1992; and 75.8 million (34.4 million) in 1993. The amount of 1,1,1-trichloroethane exported has declined since 1991. Because 1,1,1-trichloroethane may be an ozone-destroying chemical, its export and import will sharply decline in future years as a result of the Montreal Protocol. The following amounts of 1,1,1-trichloroethane (in pounds with kg in parentheses) were imported into the United States: 0.1 million (0.05 million) in 1991; 13.2 million (6.0 million) in 1992; and 0.2 million (0.1 million) in 1993 (NTDB 1994).

**4.3 USE**

1,1,1-Trichloroethane was developed initially as a safer solvent to replace other chlorinated and flammable solvents. Current uses of 1,1,1-trichloroethane and percentages of total amount devoted to each use are: vapor degreasing, 31%; cold cleaning, 18%; aerosols, 12%; adhesives, 10%; chemical intermediate, 10%; coatings and inks, 7%; textiles, 4%; electronics, 3%; other, 5% (Chemical Marketing Reporter 1992).

1,1,1-Trichloroethane is used as a solvent for adhesives (including food packaging adhesives) and in metal degreasing, pesticides, textile processing, cutting fluids, aerosols, lubricants, cutting oil formulations, drain cleaners, shoe polishes, spot cleaners, printing inks, and stain repellents, among other uses. It is used in industry primarily for cold-cleaning, dip cleaning, bucket cleaning, and vapor degreasing operations of items such as precision instruments, molds, electrical equipment, motors, electronic components and instruments, missile hardware, paint masks, photographic film, printed circuit boards, generators, switchgears, semiconductors, high vacuum equipment, fabrics, and wigs. It is also used for on-site cleaning of printing presses, food packaging machinery, and molds.

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1,1,1-Trichloroethane is also used as a chemical intermediate in the production of vinylidene chloride. It was formerly used as a food and grain fumigant (Archer 1979; Aviado et al. 1976, 1980; Merck 1989; Sax and Lewis 1987; Stewart 1983; WHO 1992).

1,1,1-Trichloroethane is used extensively in household products. In a recent “shopping basket” survey, 1,1,1-trichloroethane was found in 216 of 1,159 common household products chosen as likely to contain solvents at concentrations >0.1% by weight (Sack et al. 1992). In a similar study, 1,1,1-trichloroethane was found in 32 of 67 categories (1,026 brands sampled) of common household products at concentrations >1% by weight; trace amounts were listed in all 67 categories (Frankenberry et al. 1987; Maklan et al. 1987). Some of the several commonly used household items that may contain 1,1,1-trichloroethane are shown in Table 4-2. 1,1,1-Trichloroethane is emitted during use of items prevalent in the average home (Pleil and Whiton 1990; Wallace et al. 1987b).

#### 4.4 DISPOSAL

1,1,1-Trichloroethane has been identified as a hazardous waste by EPA, and disposal of this waste is regulated under the Federal Resource Conservation and Recovery Act (RCRA). Specific information regarding federal regulations on 1,1,1-trichloroethane disposal on land, in municipal solid waste landfills, in incinerators, and during underground injection is available in the Code of Federal Regulations (EPA 1992a, 1992b, 1992c, 1992d). Disposal of 1,1,1-trichloroethane can be accomplished through its destruction in a high temperature incinerator equipped with a hydrochloric acid scrubber. The destruction and removal efficiency (DRE) for 1,1,1-trichloroethane in hazardous wastes must attain 99.99% (Carroll et al. 1992). Potential methods of incineration include liquid injection, rotary kiln, and fluidized bed incineration (Carroll et al. 1992; HSDB 1994). Product residues and sorbent media may be packaged in a 17H epoxy-lined drum, encapsulated in an organic polyester resin, and disposed of at an approved EPA disposal site (OHM/TADS 1992). Other methods that have shown promise for the destruction of 1,1,1-trichloroethane are homogeneous sonochemical treatment for aqueous wastes (Cheung et al. 1991) and a combination of ozonation and ultraviolet treatment for groundwater (Kusakabe et al. 1991). From a laboratory feasibility study, it was concluded that the in situ biodegradation of 1,1,1-trichloroethane in soils by methane-oxidizing bacteria was not a viable bioremediation method (Broholm et al. 1991).

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**TABLE 4-2. 1,1,1-Trichloroethane in Common Household Products<sup>a</sup>**

Product	Concentration (% w/w) <sup>b</sup>
Adhesive cleaners	0.1–95.0
Adhesives	0.2–121.1
Aerosol spray paint	0.2–1.0
Battery terminal protectors	37.1
Belt lubricants	11.4–72
Brake cleaners	0.4–75.6
Carburetor cleaners	0.2–0.3
Circuit board cleaners	NS
Door spray lubricants	95.6
Drain cleaner (nonacid)	97.8
Electric shaver cleaners	2.5–20.3
Engine degreasers	0.2
Fabric finishes	77.9–85.1
Gasket removers/adhesives	0.2–1.0
General purpose spray degreasers	0.1–71.4
General purpose liquid cleaners	72.7–126.7
Ignition wire driers	24.3–43.6
Lubricants	0.1–104.5
Miscellaneous nonautomotive	12.5–67.5
Miscellaneous automotive	0.3–0.4
Oven cleaners	97
Paint removers/strippers	0.1–25.7
Primers	1.2–61.8
Rust removers	0.7
Silicone lubricants	0.2–91.1
Specialized aerosol cleaners	0.2–83.8
Spot removers	10.5–110.8
Spray shoe polish	11.4–62.3
Stereo/record player cleaners	0.7
Suede protectors	4.8–118.5
Tape recorder cleaners	0.2–101.5
Tire cleaners	0.1–90.3
Transmission cleaner/lubricant	113
TV/computer screen cleaners	0.3
Typewriter correction fluid	6–110
VCR cleaners	97.8
Video disk cleaners	0.6
Water repellents	0.2–116.2
Wood cleaners	12.3–20.4
Woodstain/varnishes/finishes	0.1–21.4

<sup>a</sup>Source: Adapted from Frankenberry et al. 1987; Maklan et al. 1987<sup>b</sup>Average recovery from spiked samples: 97±13%

w/w = weight per weight